IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPEAL FROM THE EXAMINER TO
THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of:	Kevin David Potter
Application No.:	10/532,438
Filing Date:	December 28, 2005
Examiner:	Nathan J. Bloom
Art Unit:	2624
Confirmation No.:	9117
For:	POSITIONAL MEASUREMENT OF A FEATURE WITHIN AN IMAGE

VIA EFS-WEB
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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

Dear Sir:

Pursuant to an Office Action made final and dated February 19, 2009, an Advisory Action dated June 29, 2009, and a Notice of Appeal filed July 17, 2009, in the above-identified patent application, Appellant submits an Appeal Brief as follows.

REAL PARTY IN INTEREST

The real party in interest in the subject patent application is The University of Bristol. The present application was assigned to The University of Bristol, by an assignment from the inventors recorded on December 22, 2005, in the Assignment Records of the United States Patent and Trademark Office at Reel 016931, Frame 0747.

RELATED APPEALS AND INTERFERENCES

There are no related appeals, interferences or judicial proceedings known to Applicant or Applicant's representatives which may be related to, will directly affect, or be directly affected by or have a bearing on the Board's decision on the pending appeal.

STATUS OF CLAIMS

Claims 61-64, 66-67, 69-72, 77 and 90-99 are pending in the present application. Claims 61-64,66-67, 69-72, 77 and 90-99 have been rejected pursuant to an office action made final and mailed February 19, 2009 (hereinafter, "the Final Office Action"). Claims 65 and 73-76 were canceled after the Final Office Action. Claims 61-64, 66-67, 69-72, 77 and 90-99 are being appealed; the rejection of Claims 61-64, 66-67, 69-72, 77 and 90-99 is to be reconsidered and removed.

STATUS OF AMENDMENTS

Claims 65 and 73-76 were canceled without prejudice in an Amendment After Final Office Action dated June 19, 2009. The Amendment After Final Office Action was entered by the Examiner in an Advisory Action mailed June 29, 2009 (hereinafter, "the Advisory Action").

SUMMARY OF CLAIMED SUBJECT MATTER

Independent Claim 61is directed to a method for determining coordinates of a feature comprising providing a first image including the feature, the first image comprising a plurality of pixels, determining a first estimate of coordinates of the feature to within a fraction of a pixel, translating the feature relative to the pixels by a pixel translation value,

wherein the sum of the pixel fraction and pixel translation value is an integer value, determining a second estimate of coordinates of the translated feature to within a fraction of a pixel and summing the pixel fractions of the first estimate with the second estimate to derive a refined estimate of coordinates. [Described at least at pg. 3, second and third paragraphs; pg. 4, fifth and seventh paragraphs; pg. 5, last paragraph; pg. 10, second and third paragraphs; pg. 11, second through fifth paragraphs; pg. 12; pg. 14 of the original specification filed as WO 2004/038328.]

Independent Claim 69 is directed to an apparatus for determining a position of an object comprising an image capture device arranged to provide a captured image encompassing the object, the captured image comprising a plurality of pixels, and an image processor arranged to receive the captured image and determine the position of the object by executing the method of claim 61. [Described at least at pg. 3, second and third paragraphs; pg. 4, fifth and seventh paragraphs; pg. 5, last paragraph; pg. 10, second and third paragraphs; pg. 11, second through fifth paragraphs; pg. 12; pg. 13; pg. 14, pg. 15, last two paragraphs of the original specification filed as WO 2004/038328.]

Independent Claim 71 is directed to an apparatus for determining a position of an object comprising an image capture device arranged to sequentially provide a plurality of captured images of an object, each captured image having a plurality of pixels, an image processor arranged to sequentially receive the plurality of captured images and determine the position of the object from the plurality of captured images by executing the method of claim 61, and a position comparator arranged to compare the determined position of the object for the plurality of captured images and identify whether the determined position changes in the plurality of captured images. [Described at least at pg. 3, second and third paragraphs; pg. 4, fifth and seventh paragraphs; pg. 5, last paragraph; pg. 9, fifth and sixth paragraphs; pg. 10, second and third paragraphs; pg. 11, second through fifth paragraphs; pg. 12; pg. 13; pg. 14, pg. 15, last two paragraphs; pg. 17, second, third and fourth paragraphs; pg. 18 of the original specification filed as WO 2004/038328.]

Independent Claim 77 is directed to a method for determining coordinates of a feature comprising providing at least one image including the feature, the at least one image

comprising a plurality of pixels, correlating the feature and the at least one image using a predetermined correlation function to determine coordinates of the feature to the nearest pixel, evaluating the correlation function at a plurality of sub-pixel positions in the neighborhood of the determined coordinates to provide a plurality of values and fitting the plurality of values to a further function, and differentiating the further function to determine its maximum, whereby coordinates corresponding to the maximum are coordinates of the feature to within a fraction of a pixel. [Described at least at pg. 3, second and third paragraphs; pg. 4, fifth and seventh paragraphs; pg. 5, last paragraph; pg. 10,first, second and third paragraphs; pg. 11, second through fifth paragraphs; pg. 12; pg. 13; pg. 14, pg. 15, last two paragraphs of the original specification filed as WO 2004/038328.]

Independent Claim 90 is directed to method for determining coordinates of an object, the method comprising the steps of capturing at least one first image and at least one second image of the object, each image being captured having different coordinates with respect to the other, determining the position of the object within each image, wherein determining includes, providing the first image including a feature, the first image comprising a plurality of pixels, determining a first estimate of coordinates of the feature to within a fraction of a pixel, translating the feature relative to the pixels by a pixel translation value, wherein the sum of the pixel fraction and pixel translation value is an integer value, determining a second estimate of coordinates of the translated feature to within a fraction of a pixel, summing the pixel fractions of the first estimate with the second estimate to derive a refined estimate of coordinates; and comparing the determined positions of the object to determine dimensional changes. [Described at least at pg. 3, second and third paragraphs; pg. 4, fifth and seventh paragraphs; pg. 5, last paragraph; pg. 9, last two paragraphs; pg. 10,first, second and third paragraphs; pg. 11, second through fifth paragraphs; pg. 12; pg. 13; pg. 14, pg. 15, last two paragraphs of the original specification filed as WO 2004/038328.]

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Whether the Examiner erred in rejecting Claims 61-64, 66-67, 69-72, 77 and 90-99 under 35 U.S.C. § 103(a), as being obvious over U.S. Patent No. 5,280,530 (hereinafter "Trew") in view of U.S. Patent No. 6,483,538 (hereinafter "Hu").

ARGUMENT

Claims 61-64, 66-67, 69-72, 77 and 90-99 under 35 U.S.C. § 103(a) are not obvious over Trew in view of Hu.

A. Neither Trew nor Hu determine a first estimate of coordinates of the feature to within a fraction of a pixel.

The Examiner states in the Advisory Action (Continuation Sheet) that "Trew is relied on for teaching an object tracking through a series of images, but is not relied upon for the teachings of locating the feature within an image using a template containing features." In the Final Office Action, the Examiner expressly stated in section 5 that Trew "does not teach a method of correlation wherein coordinates are determined within subpixel precision." With regard to such statements, Applicants are in agreement with the Examiner. Accordingly, it is understood that the Examiner is not relying on Trew to determine a first estimate of coordinates of the feature within a fraction of a pixel. Thus, it is admitted in the Final Office Action that Trew does not teach or suggest the invention recited in Claims 61-64, 66-67, 69-72, 77 and 90-99, for determining a first estimate of coordinates of the feature to within a fraction of a pixel.

The Examiner states in the Advisory Action (Continuation Sheet),

> "Hu has been relied upon to teach the identification of an object within an image by shifting a template relative to an image containing pixels in order to determine the location of the object within an image."

In the Final Office Action (section 5), the Examiner further states,

> "Hu teaches in column 2 lines 31-65 the correlation of a pair of images obtained from a test video and captured video by correlation of the images. Furthermore, Hu teaches in Column 3 lines 5-20 the measurement of a fractional pixel position and the shifting of the position to a 'nearest integer pixel'. Although Hu does not clearly state that the initial measurement is to a fraction of a pixel it is implied by the phrase "nearest integer pixel shift" which implies that a measurement of pixel position to a fraction of a pixel value was taken, else it would not be necessary to shrift the pixel position to the "nearest integer pixel" and would simply be stated as an integer pixel shift."

Applicants disagree with the Examiner's interpretation of Hu and point out that Hu expressly states that it does <u>not</u> determine a first estimate of coordinates of the feature to

within a fraction of a pixel, as is claimed by Applicants. Instead, Hu expressly states that "for the first iteration, only the nearest integer pixel shift position is used" (Col. 3, ll. 19-20, emphasis added). This is also evidenced in FIG. 3, boxes 48 and 52 of Hu, in which both boxes have the precise phrase, "Integer Shift Only First Iteration." Thus, the initial measurement in Hu is not made to within a fraction of a pixel; instead, the initial iteration is only an integer pixel value. Where the Examiner points to Column 3, lines 5-20 of Hu and a description of a fraction of pixel value, Applicants point out that this is where Hu begins describing pixel shifts made around the initial integer that are only made after the initial integer measurement is made. Thus, both Trew and Hu fail to teach or suggest determining a first estimate of coordinates of the feature to within a fraction of a pixel.

B. Neither Trew nor Hu sum the pixel fractions of the first estimate with the second estimate to derive a refined estimate of coordinates.

Again, it is pointed out that the Examiner properly states in the Advisory Action (Continuation Sheet) that Trew "is not relied upon for the teachings of locating the feature within an image using a template containing features." In the Final Office Action, the Examiner expressly states in section 5 that Trew "does not teach a method of correlation wherein coordinates are determined within subpixel precision." Accordingly, it is understood that the Examiner is not relying on Trew to determine a second estimate of coordinates of the translated feature to within a fraction of a pixel. And, therefore, Trew is also not relied upon by the Examiner to sum the pixel fractions of the first estimate with the second estimate to derive a refined estimate of coordinates. As such, and as is admitted in the Final Office Action, Trew does not teach or suggest Applicants' invention recited in Claims 61-64, 66-67, 69-72, 77 and 90-99, for determining a second estimate of coordinates of the translated feature to within a fraction of a pixel or for summing the pixel fractions of the first estimate with the second estimate to derive a refined estimate of coordinates.

As for Hu, please refer first to Applicants' previous remarks made in Section A, in which it is made clear that an initial measurement made by Hu is not within a fraction of a pixel; Hu's initial iteration is only for measuring an *integer* pixel value. Hu further expressly describes that it is only after the initial integer iteration that a pixel shift is made around the

initial integer, by relying on $X+X_\Delta$, $Y+Y_\Delta$, wherein X and Y are the initial integer positions and X_Δ and Y_Δ are the fractional pixel shift position values (Col. 3, ll. 29-32). Because X and Y are integer values and X_Δ and Y_Δ are fractional values, Hu, thus, does not teach or suggest summing two pixel fractions. Clearly then, with Hu there is no summing of fractional parts to give a refined estimate as is described by Applicants (e.g., para. [0050] of the Applicants' publication, US Publication No. 2006/0115133], or as is claimed. And even if Hu did sum two fractional pixel estimates, which it clearly does not, Hu never provides an estimate of the *translated* feature to within a fraction of a pixel, as is required by the second estimate of Applicants' claimed invention, because none of the estimates ever made by Hu are estimates of a *translated* feature. This is because, as has just been shown and described, Hu does not calculate a fractional pixel value of a translated feature, as will be further described below. As such, Applicants further submits that Hu fails to teach or suggest the invention recited by Claims 61-64, 66-67, 69-72, 77 and 90-99, because Hu also fails to sum pixel fractions of the first estimate with the second estimate to derive a refined estimate of coordinates.

C. Neither Trew nor Hu translate the feature relative to the pixels by a pixel translation value, wherein the sum of the pixel fraction and pixel translation value is an integer value.

Again, the Examiner expressly states in section 5 of the Final Office Action that Trew "does not teach a method of correlation wherein coordinates are determined within subpixel precision." Accordingly, it is understood that the Examiner is not relying on Trew to translate the feature relative to the pixels by a pixel translation value, wherein the sum of the pixel fraction and pixel translation value is an integer value. Thus, it is admitted in the Final Office Action that Trew does not teach or suggest the invention recited in Claims 61-64, 66-67, 69-72, 77 and 90-99, for translating the feature relative to the pixels by a pixel translation value, wherein the sum of the pixel fraction and pixel translation value is an integer value.

On page 4 of the Final Office Action the Examiner states,

> "Hu teaches in lines 5-20 of column 3 the shift of the measured pixel position to the nearest integer pixel position using the "nearest integer pixel position shift". Thus the shift referred to by Hu is the total shift value that translates the measured fractional pixel value to a "nearest integer pixel", but

> Hu does not explicitly teach the summation of a translation value to the fractional pixel position measured. However, in order to end up with a shift to a "nearest integer pixel" the fractional value needs to be mathematically manipulated in order to determine the nearest integer value. Examiner takes official notice that one of ordinary skill in the art would have recognized that only a finite number of solutions exist for moving the fractional value to the nearest integer value. The known solutions are rounding the fractional value or adding (or subtracting "add a negative value") the difference value between the fractional value and its nearest integer value. Thus it has been established that Hu teaches shifting of the pixel value to the "nearest integer" and that there are only a finite number of solutions for adjusting a fractional value to its closest integer value. A person of ordinary skill in the art at the time of the invention would have had good reason to pursue the known options of shifting to the closest integer value given the teachings of Hu. Furthermore, it would have required no more than "ordinary skill and common sense," to sum the fractional value with a difference value that is equal to the distance between the fractional value and its closest integer value

Applicants respectfully disagree with the Examiner's position with regard to Hu, as is re-written above, because in Hu, a feature in a test image (an image having a plurality of pixels) is aligned with the feature in a reference image by overlaying an "arbitrary test block" on each image. The test block may move relative to an image. Thus, the test block moves relative to <u>both</u> the pixels of an image and the feature within an image, which is not the same as and differs entirely from moving the feature relative to the pixels of the image, as is claimed by Applicants. This is an important distinction. In Hu, the position of the feature in the test image, relative to the pixels of the test image, *will not change* by shifting the test block. Instead, the arbitrary test block will 'choose' different areas of pixels upon which the FFT will be performed and a curve-fit step is provided to determine a shift position for a peak position "based upon the coefficients for the peak position and the positions up, down, left and right from the peak position" (Col. 3, ll. 14-19). The shift position is the position that the test block is then moved to, and this is relative to the test image, <u>not</u> the position the test feature is moved to relative to the test image. Thus, the shift position is <u>not</u> shifting the feature and is not shifting the feature relative to the first image (e.g., test image of Hu) but relative to an arbitrary test block and, hence, the shift is not relative to the pixels by a pixel translation value of the test image. Hu demonstrates this clearly in its FIG. 2. Therefore, shifting the test block will not have an effect on the appearance of the feature within the test image because moving the test block does not cause the object/feature of Hu to move relative

to the pixels.

Referring back briefly to statements made by the Examiner in the Final Office Action and in an interview held with the Examiner on May 7, 2009, it appears that the Examiner considers Hu to provide translating the feature relative to the pixels when Hu creates a test image and apparently it is because the Examiner believes the test image of Hu will be translated relative to both the pixels and feature of the reference image. This translation, however, is not a translation made by a pixel translation value, as is claimed by Applicants. Instead, the translation is by an arbitrary amount that will be dependent upon the effects that a video processing network (12) has on a reference video signal when producing the test video signal. It is, thus, clear that the Examiner appears to be relying an iterative movement of the test block of Hu in order to teach what is claimed by Applicants as a pixel translation value. Unfortunately, this is improper. This is because Hu expressly requires a test image to be created (which the Examiner has expressly stated is equivalent to the step of shifting a feature relative to the pixels) <u>before</u> the test block can be used to spatially align the test image with a reference image. By doing this, Hu makes it clear that the feature is shifted <u>before</u> any pixel translation value can be determined using the test block.

If the Examiner were, on the other hand, to consider the steps of aligning the test and reference images of Hu to be equivalent to shifting the feature relative to the pixels as claimed by the Applicants, it is noted that this shift is, as described above, by the arbitrary amount that is dependent on the effects that the video processing network 12 has on the reference video signal in producing the test video signal. And, this is <u>not</u> performed by the pixel translation value claimed by Applicants. Furthermore, as claimed by Applicants, a second estimate of coordinates of the translated feature is determined. Hu cannot be found to teach this because there are no further translations taught by Hu. Hu, in fact, teaches away from further translations because in Hu the images are by this point said to be aligned (Col. 3, ll. 40-44). Therefore, it is clear that Hu fails to teach or suggest translating the feature relative to the pixels by a pixel translation value, wherein the sum of the pixel fraction and pixel translation value is an integer value. Moreover, as stated previously, this cannot be derived from Trew in view of Hu.

Applicants have shown that neither Trew nor Hu provide each and every element of Applicants claimed invention or the claimed invention on its whole because both Trew and Hu fail to teach or suggest determining a first estimate of coordinates of the feature to within a fraction of a pixel and both fail to teach or suggest summing the pixel fractions of the first estimate with the second estimate to derive a refined estimate of coordinates and both fail to teach or suggest translating the feature relative to the pixels by a pixel translation value, wherein the sum of the pixel fraction and pixel translation value is an integer value. Yet, a basic requirement of establishing a *prima facie* case of obviousness is that the Examiner must show that the combination of references teaches all the claimed limitations. MPEP § 2143. Applicants respectfully submit that the Examiner has failed to establish a *prima facie* case of obviousness in order to reject Claims 61-64, 66-67, 69-72, 77 and 90-99.

CONCLUSION

In view of the errors noted above with regard to the Examiner's rejection of claims 61-64, 66-67, 69-72, 77 and 90-99, Applicant earnestly request that the Board of Patent Appeals and Interferences reverse the final rejection of the Examiner and instruct the Examiner to issue a notice of allowance as to all claims.

Dated: October 16, 2009

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CLAIMS APPENDIX: LISTING OF CLAIMS

1-60. (Canceled)

61. (Previously Presented) A method for determining coordinates of a feature comprising:

providing a first image including the feature, the first image comprising a plurality of pixels;

determining a first estimate of coordinates of the feature to within a fraction of a pixel;

translating the feature relative to the pixels by a pixel translation value, wherein the sum of the pixel fraction and pixel translation value is an integer value;

determining a second estimate of coordinates of the translated feature to within a fraction of a pixel; and

summing the pixel fractions of the first estimate with the second estimate to derive a refined estimate of coordinates.

62. (Previously Presented) The method according to claim 61, wherein each of the first and second determining steps comprise:

correlating the feature and the image using a predetermined correlation function to determine coordinates of the feature to the nearest pixel;

evaluating the correlation function at a plurality of pixel positions in the neighborhood of the determined coordinates to provide a plurality of values;

fitting the plurality of values to a further function; and

differentiating the further function to determine its turning point, whereby coordinates corresponding to the turning point provide coordinates of the feature.

63. (Previously Presented) The method according to claim 62, wherein the correlation function is evaluated at a plurality of sub-pixel positions.

64. (Previously Presented) The method according to claim 63, wherein the sub-pixel positions are closer in proximity to the determined coordinates than the pixel positions.

65. (Canceled)

66. (Previously Presented) The method according to claims 62, wherein the predetermined correlation function is a normalized greyscale correlation function.

67. (Previously Presented) The method according to claim 61, wherein the translating step, second determining step and summing step are repeated at least once.

68. (Canceled)

69. (Previously Presented) An apparatus for determining a position of an object comprising:

an image capture device arranged to provide a captured image encompassing the object, the captured image comprising a plurality of pixels; and

an image processor arranged to receive the captured image and determine the position of the object by executing the method of claim 61.

70. (Previously Presented) The apparatus according to claim 69 further comprising:
a monitor arranged to receive and display the captured image; and
an object selection means arranged to select a further object within the displayed image and to identify the further object to the image processor.

71. (Previously Presented) An apparatus for determining a position of an object comprising:

an image capture device arranged to sequentially provide a plurality of captured images of an object, each captured image having a plurality of pixels;

an image processor arranged to sequentially receive the plurality of captured images and determine the position of the object from the plurality of captured images by executing the method of claim 61; and

a position comparator arranged to compare the determined position of the object for the plurality of captured images and identify whether the determined position changes in the plurality of captured images.

72. (Previously Presented) The apparatus according to claim 71 further arranged to determine the change in the determined position, the change selected from the group consisting of magnitude, direction, and combinations thereof.

73. (Canceled)

74. (Canceled)

75. (Canceled)

76. (Canceled)

77. (Previously Presented) A method for determining coordinates of a feature comprising:

providing at least one image including the feature, the at least one image comprising a plurality of pixels;

correlating the feature and the at least one image using a predetermined correlation function to determine coordinates of the feature to the nearest pixel;

evaluating the correlation function at a plurality of sub-pixel positions in the neighborhood of the determined coordinates to provide a plurality of values and fitting the plurality of values to a further function; and

differentiating the further function to determine its maximum, whereby coordinates corresponding to the maximum are coordinates of the feature to within a fraction of a pixel.

78-89. (Previously Presented)

90. (Previously Presented) A method for determining coordinates of an object, the method comprising the steps of:

capturing at least one first image and at least one second image of the object, each image being captured having different coordinates with respect to the other;

determining the position of the object within each image, wherein determining includes;

providing the first image including a feature, the first image comprising a plurality of pixels;

determining a first estimate of coordinates of the feature to within a fraction of a pixel;

translating the feature relative to the pixels by a pixel translation value, wherein the sum of the pixel fraction and pixel translation value is an integer value;

determining a second estimate of coordinates of the translated feature to within a fraction of a pixel;

summing the pixel fractions of the first estimate with the second estimate to derive a refined estimate of coordinates; and

comparing the determined positions of the object to determine dimensional changes.

91. (Previously Presented) The method of claim 61, wherein the refined estimate of coordinates is recorded on a computer readable medium.

92. (Previously Presented) The method of claim 90, further comprising determining a 2-dimensional position of the feature within the at least first image and the at least second image, wherein a position of the at least second image is known relative to the at least first image.

93. (Previously Presented) The method of claim 92, further comprising calculating a 3-dimensional position of the feature from the 2-dimensional position for the at least two images.

94. (Previously Presented) The method of claim 61, further comprising determining coordinates of the feature within a second image, the position of the second image being known relative to the first image.

95. (Previously Presented) The method of claim 61, further comprising determining a difference in position of the feature between the first image and at least one second image, wherein the at least one second image includes coordinates and has a position known relative to the first image.

96. (Previously Presented) The method of claim 61, further comprising superimposing the first image and a second image to provide a superimposed image, wherein the position of the second image is known relative to the first image, and wherein the feature is substantially in registration.

97. (Previously Presented) The method of claim 61,wherein the method is applied for monitoring an aircraft structure.

98. (Previously Presented) The method of claim 61, wherein the first image is captured with an image capture device.

99. (Previously Presented) The method of claim 90, wherein the coordinates are recorded on a computer readable medium.

EVIDENCE APPENDIX

None.

RELATED PROCEEDINGS APPENDIX

None.